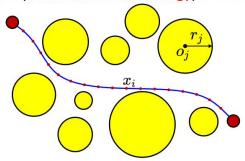
Numerical Optimization in Robotics

Homework_2 Instruction

1. Smooth Navigation Path Generation

Cubic Spline (Minimum Stretch Energy) Path Generation



Complete the smooth path generation by unconstrained minimization:

$$\min_{x_1,x_2\ldots,x_{N-1}} \mathrm{Energy}(x_1,x_2\ldots,x_{N-1}) + \mathrm{Potential}(x_1,x_2\ldots,x_{N-1})$$

The non-smooth path can provide an initial guess for decision variables.

You have to implement Broyden-Fletcher-Goldfarb-Shanno(BFGS) to optimize the trajectory by minimum the objective function given above and the constraints of the optimization problem are the obstacle in the environment.

2. Problem analysis

Cubic Spline: Cubic spline interpolation is a special case for Spline interpolation that is used very often to avoid the problem of Runge's phenomenon. This method gives an interpolating polynomial that is smoother and has smaller error than some other interpolating polynomials such as Lagrange polynomial and Newton polynomial.

For more: https://mathworld.wolfram.com/CubicSpline.html

https://en.wikiversity.org/wiki/Cubic_Spline_Interpolation

Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm: You can find details in the

Trajectory planning: here is a great survey paper for you.' **Survey of UAV motion planning**'.

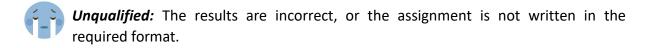
For more: you can find more details in the reference book.

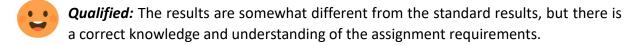
3. Assignment requirements

- ✓ Your homework should be a zip including your code, an documentation and an instruction.
- ✓ You **should** complete the homework in the given framework which means you have to finish it in C++.
- ✓ You must given an instruction named 'readme' to tell the reader how to run
 your code and check your answer.

- ✓ You *have to* give an report for this assignment which includes (1) the *workflow* and result of your homework; (2) your analysis of the homework; (3) any question or suggestion of the course and the homework.
- ✓ You can add your notes of this course to your homework.

4. Scoring Criteria





Good: The homework complete the code and make the program work.

OutStanding: The program can generate a smooth and collision-free trajectory.